

CLAIMS

What is claimed is:

- 1 1. An apparatus comprising:
2 a single network element including,
3 a full TDM cross-connect coupled to every line card slot in said single
4 network element with the same amount of bandwidth connection,
5 wherein said full TDM cross-connect is programmable on an
6 STS-1 basis, and
7 a multiple ring unit to simultaneously support multiple TDM rings.
- 1 2. The apparatus of claim 1, wherein a line card with multiple ports can be
2 installed in any one of said line card slots.
- 1 3. The apparatus of claim 1, wherein the amount of bandwidth connection is OC-
2 48.
- 1 4. The apparatus of claim 1, wherein said line card slots number greater than 6.
- 1 5. The apparatus of claim 1, wherein said multiple ring unit includes:
2 a protection group manager structure of which an instance is formed for each
3 ring provisioned in said single network element, said protection group
4 manager structure including,
5 a ring ID to distinguish between the different rings simultaneously
6 provisioned in said single network element, and
7 a ring map.
- 1 6. The apparatus of claim 5, wherein said protection group manager structure
2 further includes:
3 an east and west protection unit to identify ones of said line card slots, as well
4 as ports on line cards inserted in those line card slots.
- 1 7. The apparatus of claim 1, wherein said multiple ring unit includes:
2 a line card manager structure of which an instance is created for each line card
3 inserted in said line card slots;

4 a port manager structure of which an instance is created for each port of each
5 line card inserted in said line card slots;
6 a multi-ring manager structure to store identification information regarding each
7 ring provisioned in said single network element;
8 a protection group manager structure of which an instance is created for each
9 ring provisioned in said single network element; and
10 a network management system interface to be coupled to instances of said line
11 card manager, said port manager, said multi-ring manager, and said
12 protection group manager structures.

1 8. The apparatus of claim 7, wherein said protection group manager structure
2 includes:
3 a ring ID to distinguish between the different rings simultaneously provisioned
4 in said single network element, and
5 a ring map.

1 9. The apparatus of claim 1, wherein the single network element is to transmit
2 Operations, Administration, Maintenance and Provisioning (OAM&P) information
3 within a first set of Data Communication Channel (DCC) bytes of a Synchronous
4 Optical Network (SONET) signal to a first network element that is to connect to the
5 single network element and to transmit the OAM&P information within a second set of
6 DCC bytes of the SONET signal to a second network element that is to connect to the
7 single network element, wherein a size of the first set of DCC bytes is different from a
8 size of the second set of DCC bytes.

1 10. The apparatus of claim 9, wherein the first network element is to be included in
2 a first TDM ring of the multiple TDM rings and wherein the second network element is
3 to be included in a second TDM ring of the multiple TDM rings.

1 11. The apparatus of claim 1, wherein the single network element is to
2 communicate to a different network element through a Synchronous Optical Network
3 (SONET) signal such that the single network element is to communicate Operations,
4 Administration, Maintenance and Provisioning (OAM&P) information to the different
5 network element within Data Communication Channel bytes associated with any of the
6 Synchronous Transport Signal (STS) frames within the SONET signal.

- 1 12. The apparatus of claim 11, wherein the SONET signal includes an Optical
2 Carrier (OC)-48 signal.
- 1 13. An apparatus comprising:
2 a single multiplexing network element including,
3 a plurality of slots to be coupled to optical fiber of multiple TDM rings
4 through line cards installed in said slots,
5 a multiple ring unit to simultaneously support multiple TDM rings, and
6 a full TDM cross-connect coupled to each of said slots with the same
7 amount of high-speed bandwidth, wherein said full cross-connect
8 is programmable to switch time slots between the different TDM
9 rings.
- 1 14. The apparatus of claim 13, wherein a line card with multiple ports can be
2 installed in any one of said plurality of slots.
- 1 15. The apparatus of claim 13, wherein the amount of high-speed bandwidth is OC-
2 48.
- 1 16. The apparatus of claim 13, wherein said plurality of slots number greater than 6.
- 1 17. The apparatus of claim 13, wherein said multiple ring unit includes:
2 a protection group manager structure of which an instance is formed for each
3 ring provisioned in said single network element, said protection group
4 manager class including,
5 a ring ID to distinguish between the different rings simultaneously
6 provisioned in said single network element, and
7 a ring map.
- 1 18. The apparatus of claim 17, wherein said protection group manager structure
2 further includes:
3 an east and west protection unit to identify ones of said plurality of slots
4 coupled to a given TDM ring, as well as ports on line cards inserted in
5 those slots coupled to the given TDM ring.
- 1 19. The apparatus of claim 13, wherein said multiple ring unit includes:

2 a line card manager structure of which an instance is created for each line card
3 inserted in said plurality of slots;
4 a port manager structure of which an instance is created for each port of each
5 line card inserted in said plurality of slots;
6 a multi-ring manager structure to store identification information regarding each
7 ring provisioned in said single network element;
8 a protection group manager structure of which an instance is created for each
9 ring provisioned in said single network element; and
10 a network management system interface to be coupled to instances of said line
11 card manager, said port manager, said multi-ring manager, and said
12 protection group manager structures.

1 20. The apparatus of claim 19, wherein said protection group manager structure
2 includes:
3 a ring ID to distinguish between the different rings simultaneously provisioned
4 in said single network element, and
5 a ring map.

1 21. An apparatus comprising:
2 a network element in a hubbed network office, said network element including,
3 a plurality of line cards, wherein optical fiber from two different rings is
4 directly coupled to said network element through one or more of
5 said plurality of line cards;
6 a multiple ring unit to simultaneously support the two different rings,
7 and
8 a full TDM cross-connect coupled to each of said line cards with the
9 same amount of high-speed bandwidth, wherein said full cross-
10 connect is programmable on an STS-1 basis and is programmed
11 to switch certain time slots between the two different rings.

1 22. The apparatus of claim 21, wherein one of said rings is a TDM collector ring.

1 23. The apparatus of claim 22, wherein another of said rings is a TDM collector
2 ring.

1 53. The apparatus of claim 50, wherein said single network element further
 2 includes:
 3 a line card manager for each of said line cards;
 4 a port manager for each port on said line cards;
 5 a multi-ring manager to store identification information regarding the different
 6 rings;
 7 a protection group manager for each of the rings; and
 8 a network management system interface coupled to each of said line card
 9 managers, said port managers, said multi-ring manager, and said
 10 protection group managers.

1 54. The apparatus of claim 53, wherein each of said protection group managers
 2 includes:
 3 a ring ID to distinguish between the rings, and
 4 a ring map.

1 55. The apparatus of claim 48, said network trunk is a WDM or DWDM ring.

1 56. The apparatus of claim 55, wherein said single network element further
 2 includes:
 3 a multiple ring unit that allows for multiple TDM rings to be coupled to said
 4 single network element simultaneous.

1 57. The apparatus of claim 56, wherein said plurality of line cards are coupled to
 2 said customer premise equipment through multiple TDM access rings.

1 58. The apparatus of claim 48, wherein the same bandwidth is OC-48.

1 59. The apparatus of claim 48, wherein said full cross-connect is coupled to each of
 2 said line cards with the same amount of high-speed bandwidth.

1 60. An apparatus comprising:
 2 a first and second network element each including,
 3 a full TDM cross-connect coupled to every line card slot in said single
 4 network element with the same amount of bandwidth connection,
 5 wherein said full TDM cross-connect is programmable on an
 6 STS-1 basis,

7 a multiple ring unit simultaneously supporting multiple TDM rings, and
8 a plurality of TDM access rings coupled to line cards inserted in said line card
9 slots of said first network element to connect different pieces of
10 customer premise equipment;
11 said first and second network elements coupled to a first TDM collector ring
12 through line cards inserted in said line card slots;
13 a second ring coupled to line cards inserted in said line card slots of said second
14 network element.

1 61. The apparatus of claim 60, wherein said second ring is another TDM collector
2 ring.

1 62. The apparatus of claim 61, wherein said second ring is a WDM or DWDM ring.

1 63. The apparatus of claim 62, wherein the sum of the bandwidth of the TDM
2 access rings is greater than the bandwidth of the first TDM collector ring, and wherein
3 said full TDM cross-connect in said first network element is programmed to groom
4 traffic on said plurality of TDM access rings to said first TDM collector ring.

1 64. The apparatus of claim 60, wherein each of said first and second network
2 elements further includes:
3 a protection group manager for each of ring provisioned in that network
4 element, each of said protection group managers including,
5 a ring ID to distinguish between the different rings provision in that
6 network element, and
7 a ring map.

1 65. The apparatus of claim 64, wherein each of said protection group managers
2 further includes:
3 an east and west protection unit to identify those of said line cards in that
4 network element that are coupled to that protection group manager's
5 ring, as well as the ports on those line cards coupled to that ring.

1 66. The apparatus of claim 63, wherein each of said first and second network
2 elements further includes:
3 a line card manager for each of said line cards in that network element;
4 a port manager for each port on said line cards in that network element;

5 a multi-ring manager to store identification information regarding the different
6 rings provisioned in that network element;
7 a protection group manager for each of the rings provisioned in that network
8 element; and
9 a network management system interface coupled to each of said line card
10 managers, said port managers, said multi-ring manager, and said
11 protection group managers.

1 67. The apparatus of claim 66, wherein each of said protection group managers
2 includes:
3 a ring ID to distinguish between the rings provisioned in that network element,
4 and
5 a ring map.

1 68. A method comprising:
2 transmitting a signal to a receiving network element;
3 triggering a timeout mechanism;
4 transmitting management information within a first set of Data Communication
5 Channel (DCC) bytes of a Synchronous Optical Network (SONET) signal upon
6 receiving an acknowledgement signal from the receiving network element prior to an
7 expiration of the timeout mechanism; and
8 transmitting the management information within a second set of DCC bytes of
9 the SONET signal upon not receiving the acknowledgement signal from the receiving
10 network element prior to the expiration of the timeout mechanism.

1 69. The method of claim 68, wherein the first set of DCC bytes is larger than the
2 second set of DCC bytes.

1 70. The method of claim 68, wherein the management information includes
2 Operations, Administration, Maintenance and Provisioning information.

1 71. The method of claim 68, wherein the management information includes
2 Operations, Administration, Maintenance and Provisioning information from at least
3 two or more rings of network elements.

1 72. A method comprising:
2 transmitting management information to a receiving network element within a
3 first set of Data Communication Channel (DCC) bytes within a Synchronous Optical
4 Network (SONET) upon determining that the receiving network element can process
5 the management information within the first set of DCC bytes; and
6 transmitting the management information to the receiving network element
7 within a second set of DCC bytes within the SONET signal upon determining that the
8 receiving network element can process the management information within the second
9 set of DCC bytes.

1 73. The method of claim 72, wherein the first set of DCC bytes is larger than the
2 second set of DCC bytes.

1 74. The method of claim 72, wherein the management information includes
2 Operations, Administration, Maintenance and Provisioning information.

1 75. The method of claim 72, wherein the management information includes
2 Operations, Administration, Maintenance and Provisioning information from at least
3 two or more rings of network elements.

1 76. A method for communication of management information within a Optical
2 Carrier (OC)-48 Synchronous Optical Network (SONET) signal from a transmitting
3 network element to a receiving network element, the method comprising:

9 transmitting the management information within a second set of DCC bytes of
10 the SONET signal upon not receiving the acknowledgement signal from the receiving
11 network element prior to the expiration of the timeout mechanism.

1 79. The machine-readable medium of claim 78, wherein the first set of DCC bytes
2 is larger than the second set of DCC bytes.

1 80. The machine-readable medium of claim 78, wherein the management
2 information includes Operations, Administration, Maintenance and Provisioning
3 information.

1 81. The machine-readable medium of claim 78, wherein the management
2 information includes Operations, Administration, Maintenance and Provisioning
3 information from at least two or more rings of network elements.

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